CLAIMS

1. An optical logic gate comprising:

a first digital input for receiving a first optical digital input signal;

a digital output for outputting an optical digital output signal which is a function of the first optical digital input signal; and

a lasing semiconductor optical amplifier (LSOA) having an amplifier input and a ballast laser output, the amplifier input and ballast laser output of the LSOA coupled between the first digital input and the digital output.

2. The optical logic gate of claim 1 wherein the LSOA comprises:

a semiconductor gain medium;

an amplifying path coupled to the amplifier input and to an amplifier output and passing through the semiconductor gain medium; and

a laser cavity including the semiconductor gain medium and coupled to the ballast laser output.

3. The optical logic gate of claim 2 wherein the laser cavity has a laser threshold whereby a ballast laser signal from the laser cavity is extinguished if the ballast laser signal represents a digital zero.

4. The optical logic gate of claim 2 further comprising:

a gain element coupled between the ballast laser output of the LSOA and the digital output of the optical logic gate for adjusting an amplitude of the ballast laser signal so an amplitude of the optical digital output signal is the same as an amplitude of the first optical digital input signal when the optical digital output signal and the first optical digital input signal represent a same digital logic level.

5. The optical logic gate of claim 1 wherein the optical logic gate is an optical NOT gate.

6. The optical logic gate of claim 5 wherein:

the first digital input of the optical logic gate is coupled to the amplifier input of the LSOA;

the ballast laser output of the LSOA is coupled to the digital output of the optical logic gate; and

the LSOA has a laser threshold whereby:

if the first optical digital input signal is a digital zero, a ballast laser signal from the ballast laser output causes the optical digital output signal to be a digital one; and

if the first optical digital input signal is a digital one, the ballast laser signal from the ballast laser output causes the optical digital output signal to be a digital zero.

7. The optical logic gate of claim 6 wherein the LSOA has the laser threshold whereby if the first optical digital input signal is a digital one, the ballast laser signal is extinguished.

8. The optical logic gate of claim 1 wherein the optical logic gate is an optical NOR gate further comprising:

a second digital input for receiving a second optical digital input signal.

9. The optical logic gate of claim 8 further comprising:

an optical combiner having two inputs and an output, the two inputs coupled to the first digital input and to the second digital input, and the output coupled to the amplifier input of the LSOA;

wherein the ballast laser output of the LSOA is coupled to the digital output of the optical logic gate; and

wherein the LSOA has a laser threshold whereby:

if both the first and second optical digital input signals are a digital zero, a ballast laser signal from the ballast laser output causes the optical digital output signal to be a digital one; and

if at least one of the first and second optical digital input signals is a digital one, the ballast laser signal from the ballast laser output causes the optical digital output signal to be a digital zero.

10. The optical logic gate of claim 9 wherein the LSOA has the laser threshold whereby if at least one of the first and second optical digital input signals is a digital one, the ballast laser signal is extinguished.

11. The optical logic gate of claim 1 wherein the optical logic gate is an optical NAND gate further comprising:

a second digital input for receiving a second optical digital input signal.

12. The optical logic gate of claim 11 further comprising:

an optical combiner having a first input and a second input and an output, the first combiner input coupled to the ballast laser output of the first LSOA, and the output coupled to the digital output of the optical logic gate; and

a second LSOA having an amplifier input coupled to the second optical digital input and a ballast laser output coupled to the second combiner input.

wherein the first LSOA has a laser threshold wherein, response to the first optical digital input signal being a digital signal:

if at least one of the first and second optical digital input signals is a digital zero, a ballast laser signal from the ballast laser output causes the optical digital output signal to be a digital one; and

if both the first and second optical digital input signals are a digital one, the ballast laser signal from the ballast laser output causes the optical digital output signal to be a digital zero.

13. The optical logic gate of claim 12 wherein:

in response to the first optical digital input signal being a digital one, a ballast laser signal from first LSOA is a digital zero;

in response to the second optical digital input signal being a digital one, a ballast laser signal from second LSOA is a digital zero;

in response to the first optical digital input signal being a digital zero, a ballast laser signal from first LSOA is a digital one; and

in response to the second optical digital input signal being a digital zero, a ballast laser signal from second LSOA is a digital one.

14. The optical logic gate of claim 1 wherein the LSOA is a vertical lasing semiconductor optical amplifier (VLSOA).

15. The optical logic gate of claim 1 wherein the LSOA is a transverse lasing semiconductor optical amplifier (TLSOA).

16. The optical logic gate of claim 1 wherein the LSOA is a longitudinal lasing semiconductor optical amplifier (LLSOA).

17. An optical latch, comprising:

a set input;

a reset input;

a first output;

a second output;

a first lasing semiconductor optical amplifier (LSOA), comprising:

an input for receiving optical signals and connected to the set input; and

a laser output connected to the first output for outputting a first laser output optical signal in response to the received optical signals;

a second LSOA, comprising:

an input for receiving optical signals and connected to the reset input and to the laser output of the first LSOA; and

a laser output connected to the second output and to the input of the first LSOA for outputting a second laser output optical signal in response to the received optical signals;

wherein, in response to a high signal being input to the set input, and a low signal being input to the reset input, reaching a first stable state where the first output is low and the second output is high; and

wherein, in response to a high signal being input to the reset input, and a low signal being input to the set input reaching a second stable state where the first output is high and the second output is low.

18. The optical latch of claim 17, wherein the first LSOA further comprises:

a laser cavity with an optical path;

an amplifying path connected to the input and passing through the laser cavity for propagating the optical signals received at the input;

a pump input connected to the laser cavity for receiving a pump for exceeding a lasing threshold for the laser cavity; and

wherein the laser output outputs the first laser output optical signal in response to the received optical signals propagating through the amplifying path.

19. The optical latch of claim 17, further comprising:

a first combiner connected to the set input, the input of the first LSOA, and the laser output of the second LSOA for receiving optical signals from the set input and the laser output of the second LSOA and outputting a combined optical signal to the input of the first LSOA; and

a second combiner connected to the reset input, the input of the second LSOA, and the laser output of the first LSOA for receiving optical signals from the set input and the laser output of the first LSOA and outputting a combined optical signal to the input of the second LSOA.

20. The optical latch of claim 17, further comprising:

a first splitter connected to the laser output of the first LSOA, the input of the second LSOA, and the first output for receiving optical signals from the laser output of the first LSOA and outputting the received optical signals to the input of the second LSOA and the first output; and

a second splitter connected to the laser output of the second LSOA, the input of the first LSOA, and the second output for receiving optical signals from the laser

output of the second LSOA and outputting the received optical signals to the input of the first LSOA and the second output.

21. An optical logic gate, comprising:

a lasing semiconductor optical amplifier (LSOA) having an amplifier input, a ballast laser output, and an amplifier output;

a time delay having an input coupled to the ballast laser output for receiving a ballast laser output signal, an output coupled to the amplifier input for, at a later time, sending the ballast laser output optical signal to the amplifier input; and

a digital output coupled to the amplifier output for outputting a periodic substantially square waveform optical signal.

22. The optical logic gate of claim 21, wherein the time delay is a length of optical fiber.

23. The optical logic gate of claim 21, wherein the time delay is silicon.

24. The optical logic gate of claim 21, the LSOA further comprising a laser cavity with an optical path having a variable optical path length.

25. The optical logic gate of claim 24, the laser cavity of the LSOA further comprising:

a first mirror; and

a second mirror separated from the first mirror by a distance, the distance being variable.

26. The optical logic gate of claim 25, wherein the first mirror is a micro electro-mechanical system (MEMS) mirror with a variable position.

27. The optical logic gate of claim 26, the LSOA further comprising a conducting layer for varying the position of the first mirror by applying a selected voltage between the first mirror and the conduction layer.

28. The optical logic gate of claim 21, the LSOA further comprising a tunable region with a selectable refractive index.

29. The optical logic gate of claim 21, the time delay being a variable time delay.

30. The optical logic gate of claim 21, the time delay further comprising a tunable region with a selectable refractive index.